

DSN Command System Performance Evaluation

W. G. Stinnett
DSN Engineering and Operations Office

This article presents a general performance description of the DSN Command System as configured for support of the Mariner Mars 1971 and Pioneer 10 missions. Included are statistics related to system reliability and availability. A comparison of command activity is presented for previous Mariner- and Pioneer-type missions.

I. Introduction

The DSN Multiple-Mission Command System has now been utilized for significant periods of the *Mariner Mars 1971 (Mariner 9)* and *Pioneer 10* missions. There exists enough operational experience that a performance evaluation can be made on this system. The system has been utilized in support of *Mariner 9* and *Pioneer 10* for over a year. In comparison with past missions of similar length, a significant increase in the number of commands transmitted has been realized.

II. Performance Evaluation

A. Operational Characteristics

The primary characteristic of the DSN Multiple-Mission Command System, as configured for support of the *Mariner 9* and *Pioneer 10* missions, has been the automatic control of the Deep Space Station (DSS) Command Subsystem from the Space Flight Operations Facility (SFOF). This control is established via a standard high-speed data system interface between the SFOF and a DSS. Both Project and DSN personnel are responsible for

transmitting high-speed data blocks to the DSS. Table 1 describes these operational functions. Both the DSN and the flight projects have benefited from the existence of the present command system.

The DSN has realized the following operational improvements from the present command system:

- (1) Command system operations procedures are almost entirely mission-independent.
- (2) A major portion of the operations functions is performed from the SFOF, requiring fewer DSS personnel.
- (3) Excessive verbal communication with DSS/Projects is not required for command system operations.
- (4) Project-dependent personnel or mission-dependent equipment is not required at DSSs.
- (5) Command entry is entirely the responsibility of Project personnel (except for infrequent manual entry at a DSS).
- (6) Command data interface is standard with both projects.

The flight projects (*Mariner 9* and *Pioneer 10*) have realized the following operational benefits from the present command system:

- (1) Volume of commands per given time period has increased.
- (2) Less verbal coordination with DSN/DSS personnel has been required.
- (3) System is more responsive to real-time decisions/changes. Verbal communication with DSN/DSS is minimal.

B. Highlights of Command Activity

The present DSN Command System has been utilized in support of the *Mariner 9* and *Pioneer 10* launch phases, trajectory correction maneuvers, and cruise periods. *Mariner 9* was supported during Mars orbit insertion and orbit sequences. The best test of the system has been its use in updating the *Mariner 9* on-board computer in support of picture-taking sequences. Large volumes of commands in a relatively short period of time have been transmitted to *Mariner* on a day-to-day basis.

C. Volume of Commands

By the end of May 1972, over 37,000 commands to *Mariner 9* and over 4000 commands to *Pioneer 10* had been transmitted. Figure 1 shows the DSN command history of the *Pioneer*- and *Mariner*-type missions. As can be seen, a significant increase in DSN command activity has occurred in support of the *Mariner 9* and *Pioneer 10* missions. This level of command activity is expected to be sustained in support of the present missions, plus *Pioneer G*, *Mariner Venus-Mercury*, *Helios*, and *Viking* missions. A DSN Command System, with minor modifications, is planned for use by these future missions.

D. Performance

A measure of the performance of the DSN Command System for support of the *Mariner 9* and *Pioneer 10* missions is shown in Table 2. As can be seen, the total system

has been available to the projects between 96 and 98% of the time. The majority of the outages has been due to the failures of the Space Flight Operations Facility (SFOF) IBM 360-75 computer. Backup commanding via manual means at a DSS would bring a "command capability" percentage to greater than 99%. The failures in the IBM 360-75 computer have been almost entirely caused by problems outside the command system, e.g., other system processing failures, analysis program failures, computer system failures. The net result of these failures from whatever source is the unavailability of the "complete" DSN Command System.

Problems and anomalies have occurred in the use of the command system. In the first versions of the "systems" for use by the *Mariner 9* and *Pioneer 10* missions, failures in the command system caused interruption in project command sequences. The "final" version of the software utilized for *Mariner 9* support has been in use for approximately seven months. This version has the following performance record:

Commands transmitted: >36,000

Commands aborted: 3

Abort rate: 0.008%

Recent fixes to problems associated with the system utilized for support of the *Pioneer 10* mission have been implemented. This new version has not been in use long enough to gather statistics similar to those above.

III. Conclusions

The use of the DSN Command System in support of the *Mariner 9* and *Pioneer 10* missions has proven to be a very valuable tool. Increased command activity requirements of the present and future missions have outdated former modes of command operations. The automatic operation of the DSN Command System from the SFOF has proven to be a reliable and efficient means to provide the support necessary for these increased command activity requirements.

Table 1. DSN Command System high-speed data control from the SFOF to a DSS

High-speed block type	Purpose	Responsibility for transmission
Configuration message	To establish the correct mission configuration of the multiple-mission hardware at the DSS	DSN
Standards and limits message	To establish the appropriate alarm and abort conditions of the DSS command subsystem	DSN
Test command message	To test the command system end-to-end prior to flight project use	DSN
Recall request message	To recall data from the DSS concerning commands, configuration, and standards and limits	DSN and Project
Command message	To transmit commands from the SFOF to a DSS	Project
Command enable/disable message	To allow transmission of a command from the DSS to the spacecraft; to delete a command from the DSS command subsystem	Project

Table 2. DSN Command System: Command activity and percentage down

Activity	Deep Space Station							
	11	12	14	41	42	51	61	62
Commands to <i>Mariner 9</i>	—	3303	1041	3359	65	109	—	29621
Commands to <i>Pioneer 10</i>	334	274	—	1409	1265	639	495	—
Percent down ^a — <i>Mariner 9</i>	—	3.9	3.8	3.2	2.4	4.0	—	4.0
Percent down ^a — <i>Pioneer 10</i>	5.1	2.5	—	2.2	2.6	3.3	3.8	—

^aPercent down calculation: Time total system unavailable for project use divided by DSS track time.

Time system unavailable includes SFOF IBM 360/75, HSDL, and DSS command subsystem outages.

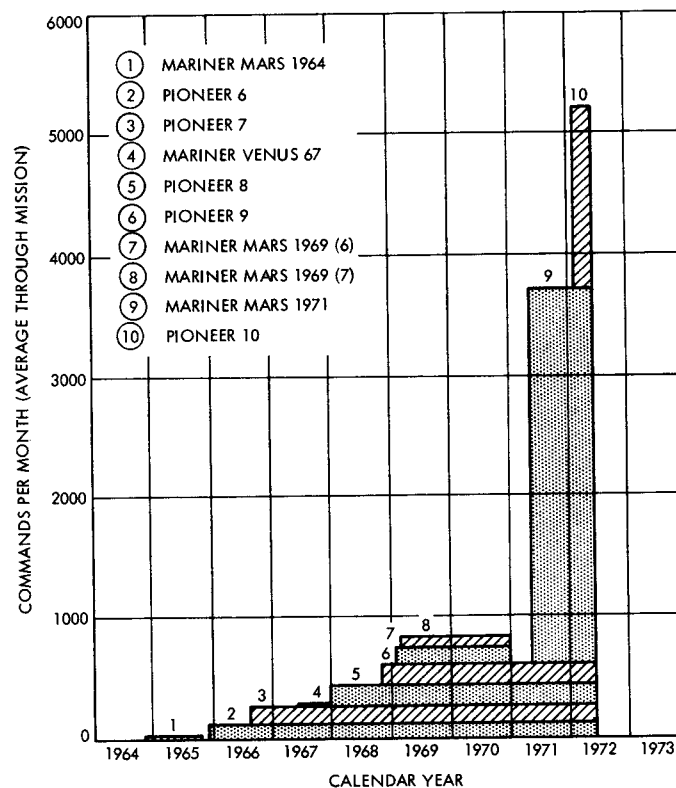


Fig. 1. DSN command history